UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte MAKOTO IIDA and MASANORI KIMURA

Appeal 2007-1771
Application 10/009,910
Technology Center 1700

Decided: October 31, 2007

Before THOMAS A. WALTZ, JEFFREY T. SMITH, and
LINDA M. GAUDETTE, *Administrative Patent Judges*.

THOMAS A. WALTZ, *Administrative Patent Judge*.

DECISION ON APPEAL

This is a decision on an appeal under 35 U.S.C. § 134 from the Primary Examiner's final rejection of claims 1-10, which are the only claims pending in this application. We have jurisdiction pursuant to 35 U.S.C. § 6(b).

According to Appellants, the invention is directed to a method for producing a silicon single crystal where the silicon single crystal is pulled while doping with carbon and controlling the V/G ratio (V is the crystal pulling rate and G is the crystal solid-liquid interface temperature gradient) such that an N-region is formed over the entire plane of the crystal (Br. 2).[1] Independent claim 1 is illustrative of the invention and a copy of this claim is reproduced below:

> 1. A method for producing a silicon single crystal, wherein the silicon single crystal is pulled while doping with carbon and controlling V/G (V: crystal pulling rate, G: crystal solid-liquid interface temperature gradient along a growing axis) to have an N-region over an entire plane of the crystal, the silicon single crystal being pulled at a rate greater than the rate of pulling a silicon single crystal with no carbon doping, and in which the silicon crystal is grown in accordance with Czochralski method.

The Examiner has relied on the following prior art references as evidence of obviousness:

Hourai	US 5,954,873	Sep. 21, 1999
Iida	US 5,968,264	Oct. 19, 1999
Tamatsuka	US 6,162,708	Dec. 19, 2000
Fujikawa	US 6,277,501 B1	Aug. 21, 2001
Asayama	US 6,641,888 B2	Nov. 4, 2003

ISSUES ON APPEAL

Claim 9 stands rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement (Ans. 3).[2]

The following rejections under 35 U.S.C. § 103(a) are before this panel for review in this appeal:

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[1] We refer to and cite from the “Substitute Appeal Brief” dated Sep. 26, 2005.

[2] We refer to and cite from the “Examiner’s Answer” dated Dec. 23, 2005.

(1) claims 1 and 5 over Iida in view of Fujikawa (Ans. 3);

(2) claims 2, 6, and 9-10 over Iida in view of Fujikawa and Tamatsuka (Ans. 5);

(3) claims 3 and 7 over Iida in view of Fujikawa and Hourai (Ans. 6);

(4) claims 4 and 8 over Iida in view of Fujikawa, Tamatsuka, and Hourai (Ans. 6);

(5) claims 1, 3, 5, 7, and 9 over Hourai in view of Fujikawa (Ans. 7);

(6) claims 2, 4, 6, 8, and 10 over Hourai in view of Fujikawa and Tamatsuka (Ans. 9); and

(7) claims 1-8 over Asayama in view of Iida or Hourai (Ans. 10).

Appellants contend that BMD is the density of internal microdefects due to oxide precipitates, which grow from oxygen precipitation nuclei, and thus it is impossible that the density of oxygen precipitation nuclei is smaller than the BMD density (Br. 5-7).

Appellants contend that dopant dependence on the V/G value is not shown in the cited prior art, any assumption that experimental changing of the pulling rate is carried out during carbon doping is erroneous, and the Examiner has not identified any reference which discloses a silicon single crystal is pulled while doping with carbon to have a N-region over the entire plane of the crystal (Br. 8, 10 and 13).

Appellants contend that in order for the gradient G to be changed, it would be necessary to change the internal structure of the furnace, and thus any experimentation would only be with the pulling rate V (Br. 8).

The Examiner contends that the quantity of oxygen precipitation nuclei cannot be implicitly determined from the quantity of BMDs (Ans. 13). The Examiner further contends that the original Specification does not

teach any correlation between the number of oxygen precipitation nuclei and the number of BMDs (Ans. 14).

The Examiner contends that one of ordinary skill in this art would have arrived at the claimed subject matter by routine experimentation in view of the teachings of the prior art (Ans. 13 and 15-18).

Accordingly, we determine the issues presented by the record in this appeal as follows: (1) is there implicit basis or support in the original disclosure for the number of oxygen precipitation nuclei as recited in claim 9 on appeal?; and (2) would one of ordinary skill in this art need only routine experimentation for optimization of the values of V and G for carbon-doped silicon single crystals to arrive at the claimed subject matter?

We determine that the Examiner has established a prima facie case for each ground of rejection, which prima facie case has not been adequately rebutted by Appellants' arguments. Therefore we AFFIRM each ground of rejection presented in this appeal essentially for the reasons stated in the Answer, as well as those reasons set forth below.

OPINION

A. The Rejection under § 112, ¶1

We determine the following factual findings from the record in this appeal:

(1) the original Specification discloses that the "BMD density in a bulk portion is 1×10^9 number/cm^3 or more" (Specification 13:3-4);

(2) the original Specification discloses that the wafer has "oxide precipitates of 1×10^9 number/cm^3 or more" (Specification 12:3-4);

(3) the original Specification teaches that oxygen precipitation nuclei cause oxide precipitates, which in turn cause BMDs, but discloses no number of oxygen precipitation nuclei (Specification 5-7; Br. 5).

The Examiner has found that the number of oxygen precipitation nuclei recited in claim 9 on appeal has no support in the original disclosure (Ans. 3; *see* factual finding (3) listed above). Appellants have not presented any argument or evidence that this number is explicitly disclosed in the original disclosure. Therefore we determine that the Examiner has met the initial burden of proof in establishing prima facie a lack of written description for this number. *See In re Alton,* 76 F.3d 1168, 1175, 37 USPQ2d 1578, 1583 (Fed. Cir. 1996).

Appellants contend that the contested limitation is implicitly described in the original disclosure since the density of BMD that the oxygen precipitation nuclei grow is 1×10^9 number/cm^3 or more, and it is impossible for the density of the oxygen precipitation nuclei to be smaller than the BMD density (Br. 5-7). However, as correctly stated by the Examiner (Ans. 14), the original disclosure does not teach any correlation or relationship between the density of BMDs and the density of oxygen precipitation nuclei (*see* factual findings (1) and (2) listed above). Although the correlation may be 1:1:1 for number of BMDs: oxide precipitates: oxygen precipitation nuclei, *on this record* Appellants have not established that this relationship or correlation was disclosed in the original Specification or known in the art before their filing date. Therefore we determine that Appellants have not met their burden of proof. Accordingly, we affirm the Examiner's rejection

of claim 9 on appeal for failing to comply with the written description requirement of the first paragraph of § 112.

B. The Rejections based on § 103(a)

As correctly noted by the Examiner, Appellants do not challenge each § 103(a) rejection separately but focus on the teachings of the applied prior art as a whole (Ans. 15; Br. 7). Accordingly, we determine the following factual findings from the record in this appeal:

(4) Appellants admit that it is "known that the densities of both point defects depend on the relationship between a crystal pulling rate (growing rate) V and a temperature gradient G" in forming a silicon single crystal in the CZ (Czochralski) method (Specification 2-3);

(5) Hourai discloses that careful control of the pulling rate V and the temperature gradient G permits silicon single crystals to be formed free of OSF (oxidation-induced stacking fault) rings and other defects when using the CZ method (Abstract; col. 1, ll. 59-65; col. 3, ll. 42-56; and col. 4, ll. 50-57);

(6) Hourai teaches how G can be controlled, how V and G can be adjusted to maintain a defect-free region in the crystal, and the effect the method of calculating G has on the V/G value (col. 3, ll. 58-65; and col. 6, ll. 33-36 and 55-59);

(7) Iida discloses forming silicon single crystals by the CZ method, and that it is known that the concentration of vacancies and/or interstitials depend on the relation between V and G; Iida teaches control or adjustment of V and G so

that the crystal is grown in the neutral (N) region which is formed over the entire crystal cross-section (Abstract; Figs. 3, 4, and 9B; col. 1, ll. 49-57; col. 3, ll. 39-53; col. 4, ll. 38-44; col. 4, l. 62-col. 5, l. 4; col. 5, ll. 9-12; col. 6, ll. 49-53; col. 8, ll. 62-67; col. 10, ll. 1-6; col. 15, ll. 3-7; and col. 17, ll. 36-40);

(8) Fujikawa teaches enhanced gettering capabilities for a variety of impurities found in silicon single crystals grown by the CZ method by intentionally making the carbon concentration high, since it was found that the carbon concentration enables the promotion of the generation and growth of oxygen precipitation nuclei, thus promoting desirable gettering functions (Abstract; Fig. 18; col. 1, ll. 21-26; col. 6, ll. 23-26, 46-52, and 59-67; col. 9, ll. 15-21; col. 10, ll. 10-12; col. 15, ll. 1-4; and col. 18, ll. 10-16);

(9) Tamatsuka teaches that growing a silicon single crystal by the CZ method while doping with nitrogen promotes the gettering capability (Abstract; col. 1, ll. 30-32; col. 2, ll. 1-8; col. 3, ll. 60-62; col. 6, ll. 5-14; and col. 11, ll. 49-54);

(10) Asayama discloses a high gettering capability for silicon single crystals by doping with nitrogen or nitrogen and carbon, and teaches that carbon enhances the formation rate and growth rate of oxide precipitates (Abstract; col. 1, ll. 9-18; col. 3, ll. 62-63; col. 4, ll. 24-25; col. 5, ll. 38-43 and 49-54; col. 6, ll. 64-67; col. 7, ll. 29-33; col. 10, ll. 56-58; and col. 12, ll. 58-60); and

(11) Both Fujikawa and Asayama teach that it was known in the prior art to dope silicon single crystals with carbon at high concentrations (Fujikawa, col. 5, ll. 20-25; and Asayama, col. 3, ll. 7-13 and 20-23).

Under 35 U.S.C. § 103, the factual inquiry into obviousness requires a determination of: (1) the scope and content of the prior art; (2) the differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) secondary considerations. *See Graham v. John Deere Co. of Kansas City,* 383 U.S. 1, 17-18, 148 USPQ 459, 467 (1966). As held by the Supreme Court in *KSR Int'l Co. v. Teleflex, Inc.,* 127 S. Ct. 1727, 1739, 82 USPQ2d 1385, 1395 (2007), "[t]he combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results." The Court also held that "if a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill." *KSR,* 127 S. Ct. at 1740, 82 USPQ2d at 1396. Finally, the Court held "that when a patent 'simply arranges old elements with each performing the same function it had been known to perform' and yields no more than one would expect from such an arrangement, the combination is obvious." *KSR,* 127 S. Ct. at 1740, 82 USPQ2d at 1395, *quoting* from *Sakraida v. AG Pro, Inc.,* 425 U.S. 273, 282 (1976). It is also generally held that the discovery of an optimum value of a result-effective variable in a known process is obvious. *See In re Boesch,* 617 F.2d 272, 276, 205 USPQ 215, 219 (CCPA 1980); *see also, In re Aller,* 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955).

Applying the preceding legal principles to the factual findings in the record of this appeal, we determine that the Examiner has correctly established a prima facie case of obviousness, which prima facie case has not been adequately rebutted by Appellants' arguments. As clearly shown by factual findings (4) through (7) listed above, we determine that it was well known in the art of pulling silicon single crystals to control and adjust the pulling rate V and temperature gradient G in the CZ method to optimize the V/G value to have an N-region over an entire plane of the crystal to produce a crystal free of defects. As also clearly shown by factual findings (8) through (11) listed above, we determine that it was well known in the art to dope silicon single crystals formed by the CZ method with high concentrations of carbon to achieve a high gettering capability, thus reducing impurities in the crystal. Appellants are correct that no one reference discloses or suggests dopant dependence on the V/G value (Br. 10). However, we determine that the combination of old elements (adjusting V and G values to an optimum, with carbon doping) with each performing the same function it had been known to perform (to yield crystals free of defects and enhance gettering capabilities, respectively) while yielding no more than one would have expected from such an arrangement would have been obvious. *See KSR, supra.*

For the foregoing reasons and those stated in the Answer, we affirm all of the rejections based on § 103(a) presented for review in this appeal. The decision of the Examiner is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED

tc/ls

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